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Abstract

Human activities are degrading ecosystems worldwide, posing existential threats for biodiversity and humankind. Slowing and reversing this degradation requires profound and widespread changes to human behaviour. Behavioural scientists are therefore well placed to contribute intellectual leadership in this area. This Perspective aims to stimulate a marked increase in the amount and breadth of behavioural research addressing this challenge. First, we describe the significance of the biodiversity crisis for human and non-human prosperity and the central role of human behaviour in reversing this decline. Next, we discuss key gaps in our understanding of how to achieve behaviour change for conservation and suggest how to identify key behaviour changes and actors capable of improving biodiversity outcomes. Finally, we outline the core components for building a robust evidence base and suggest priority research questions for behavioural scientists to explore in opening a new frontier of behavioural science for the benefit of nature and human wellbeing.

The problem

A recent global synthesis estimates that 75% of Earth's land surface has been significantly altered by human activities, 66% of the ocean has been negatively affected, and 85% of wetland areas have been lost[1]. The combined effects of land-use change and habitat fragmentation, overharvesting, invasive species, and pollution and climate change have resulted in an average decline in monitored populations of vertebrates of nearly 70% since 1970 as well as extinction rates which are orders of magnitude higher than the average seen in the geological record[2–4]. The threats to species are so severe that there is growing scientific consensus that we are entering the sixth mass extinction – the fifth being the Cretaceous-Paleogene extinction event 66 million years ago that killed all non-avian dinosaurs[5].

The rapid degradation of ecosystems and associated loss of species is of profound importance, for at least three reasons. First, there are powerful moral arguments that people should not cause the avoidable extinction of perhaps one million or more species[6]. Second, human prosperity depends on wild habitats and species for a host of essential benefits, from climate regulation, biogeochemical and flood regulation to food production and the maintenance of mental wellbeing[7,8]. Their deterioration thus presents an existential challenge[1]. Third, evidence suggests that pandemics resulting from greater disease transmission between humans and wild animals[9,10] will become more regular features of the future unless our interactions with wild species changes fundamentally[9,11–14]. The COVID-19 pandemic – with devastating effects on societies and economies worldwide – illustrates the consequences of deteriorating wild habitats and biodiversity exploitation.

Humanity's impacts on biodiversity are the result of our actions, from unsustainable wildlife harvesting through to the rising demand for environmentally damaging foods[1,15–18]. Importantly, these actions are undertaken by actors in myriad roles – including consumers, producers, and policymakers – who directly or indirectly impact ecosystems and wild species[19]. For example, the rapid clearance of the Amazon is driven by the actions of consumers across the globe who eat beef, policymakers who undervalue forest retention, and ultimately local ranchers who are incentivized to convert forest to pasture[20,21]. Similarly, the illegal trade of wildlife (e.g., rhino horn, pangolin scales, tiger bones, or elephant ivory) involves suppliers who hunt the animals, intermediaries who facilitate trade and transport the products to market, and domestic and international consumers[17,22–24]. The direct impacts on biodiversity are, however, not only centred in less developed countries. For example, the continued illegal persecution of birds of prey in UK uplands is the result of choices by some gamekeepers to shoot and poison raptors to limit their predation of red grouse, by some hunters to pay exceptionally high prices for large daily “bags” of grouse, and by policymakers to resist attempts at tighter regulation of the shooting industry[25].

Because human activities are responsible for driving ecosystem decline, reversing current trends will require profound and persistent changes to human behaviour, across actors and scales[26]. Despite its critical importance, the science of behaviour change and its application has not been a principal focus of research in conservation science[26–31]. Conservation scientists have been slow to incorporate behavioural science evidence into their theories and interventions[26,29,32–34]. Likewise, biodiversity conservation has not been a strong focus of study for behavioural scientists. One exception is research on common-pool resource management and commons dilemmas, which has a long history tracing back to the 1970s[35–38]. This research tradition has tackled issues closely linked to biodiversity conservation and foreshadows many contemporary and interdisciplinary analyses. More recently, social-marketing techniques have been used to tackle a variety of biodiversity problems and their potential is increasingly recognized[39,40]. For example, a recent study in the Philippines, Indonesia, and Brazil used locally tailored social marketing campaigns to shift social norms and increase sustainable fishing among communities of small-scale fisheries[41]. Yet, while the number of successful applications of behavioural science to biodiversity conservation is increasing, they remain rare and often suffer from methodological limitations[42]. The conservation evidence base is consequently patchy and generally poorly informed by behavioural science[29,43].

Meanwhile, behavioural science has made gains in understanding how to encourage prosocial behaviour, including actions that ultimate affect biodiversity outcomes. A growing body of research related to climate change suggests the importance of social norms, risk communication, emotion, and choice architecture in changing behaviour[44–48]. Behavioural science has been incorporated into some public efforts to encourage sustainable land management in the United States and the European Union[49,50]. Nevertheless, there are still few applications of behavioural science to explicitly address the most important proximate causes of biodiversity loss (overharvesting, invasive species, habitat loss and degradation). Behavioural insights from research related to climate change, land management, consumer behaviour, voting, and program enrolment can inform the multi-scale approach needed to deliver effective biodiversity conservation, but this research has not been systematically linked to address conservation challenges. Moreover, the literature is heavily focused on households and not well-developed for other important actors[48,51]. We therefore see unrealized potential for behavioural science to address a snowballing biodiversity crisis.

Increasing scientific engagement

Behavioural scientists might be motivated to become engaged in biodiversity conservation research for at least three reasons. First, biodiversity conservation is essential for the long-term prosperity of people and nature, with unique challenges that offer a new arena for exploring critically important research questions and for testing behaviour change interventions. Such research can contribute to the mitigation of a global and existential threat, as well as to direct improvements to the livelihoods of often vulnerable communities.

Second, engaging in biodiversity conservation research offers behavioural scientists a chance to investigate theories and interventions in new contexts and populations[52–54]. A key requirement for increasing the generalisability of behavioural science is to ramp up research activities outside North America, Australia, and Europe[55,56]. Due to the importance of the tropics for biodiversity, the focus of many conservation interventions is in Africa, Latin America and Asia, providing opportunities to test theory in contexts which are less WEIRD (Western, Educated, Industrialized, Rich, and Democratic). A related challenge is the need to shift behaviours of many actors (see below). Behaviour-change interventions in other sectors have been criticised for being too narrowly focused on end-users[57,58]: Conservation problems provide opportunities for targeting the behaviours of a far broader array of stakeholders.

Finally, conservation scientists and practitioners are keen to collaborate more with behavioural scientists[59,60]. An increasing number of conservation scientists and practitioners recognise the need for stronger integration of behavioural science in order to design interventions which are grounded in greater understanding of their research the social, motivational, and behavioural drivers of people's actions[26,33,61,62]. Naturally, as with all interdisciplinary collaborations, these collaborations will have their challenges[62]. However, recent examples show that effective collaborations can produce novel and mutually beneficial research that suggests practical routes to achieving behaviour change for biodiversity conservation[41,63–66].

The remainder of this Perspective seeks to encourage greater engagement of behavioural scientists in conservation-targeted research. We first highlight the diversity of actors involved in threats to biodiversity and the scope of behaviour changes required. In doing so, we propose routes to identifying key behaviour changes and prioritising among them, based on their potential for improving biodiversity outcomes. We suggest research questions for better understanding how to influence different actors' behaviours and for improving conservation interventions, and close by making recommendations for how to expand the conservation evidence base systematically.

Identifying key actors and behaviour changes

Threats to biodiversity are rarely caused by a single action of a single actor. Rather, they typically result from multiple behaviours by multiple actors over large spatial and temporal scales[29]. It can thus be very challenging to identify those behaviour changes with the greatest promise of being achieved and of positively impacting biodiversity. Doing so requires systematically considering the proximate causes and underlying drivers of threats to conservation targets (e.g., specific populations or ecosystems), the actors involved (e.g., producers and consumers), and the harmful behaviours performed by those actors[19,33,38,67].

The proximate threats to wild species and the places they live can be categorised into four main groups: habitat loss and degradation, overharvesting, invasive species, and climate change and pollution[68–70]. These threats also interact, with species or ecosystems commonly impacted by multiple threats, sometimes with amplifying effects. For example, the spread of some invasive plants is thought to be exacerbated by elevated nitrogen deposition and atmospheric CO_2 concentrations[71,72]. Proximate threats are driven by broader societal processes, including rising demand for food and consumer goods, weak local, national, and international institutions that struggle to ensure the protection of public goods, population growth, and the growing disconnect of people from nature due to increasing urbanisation and indoor recreation[73]. The interventions conservationists often deploy to tackle proximate threats, including removing invasive species, restoring wetlands, or propagating threatened species in captivity, are not primarily about changing people's behaviour (although even in these examples those carrying out the management actions must be trained and incentivised, and behaviours must change if these threats are not to recur). However, given the pervasive importance of human activities in conservation problems, many interventions do involve attempts to alter behaviour. If behavioural science is to improve the effectiveness of these efforts, an important first step is to identify the main actors responsible for a given threat and the changes in their behaviour that might be required to alleviate it.

One tool for mapping the actors and behaviours impacting a conservation target is to build a threat chain[31]. This is a simplified summary of knowledge of the reasons for the unfavourable status of a species or ecosystem, from changes in ecological dynamics through to the socioeconomic mechanisms thought to be responsible, and their underlying drivers. Once this putative causal chain has been constructed, the main actors in the chain can be identified, along with changes in their behaviour that might potentially reduce the particular threat. Where conservation targets are impacted by multiple threats this process can be repeated, with the likely impact of different behaviour changes compared across threats in order to identify the most promising interventions for delivering those changes.

Using Amazon deforestation (as an example of habitat loss) for illustration (Fig. 1; red boxes)[20,21], the extirpation of forest-dependent species and ecosystem processes resulting from conversion to pasture has been caused (*inter alia*) by a combination of rising global demand for beef, poor pasture and livestock management, the absence of incentives for forest retention, and the practice of establishing *de facto* land tenure via forest clearance. Underlying drivers include weak governance at multiple levels and rising per capita demand for beef among a growing population in Brazil and beyond. Potential behaviour changes that might be targeted to reduce deforestation (blue boxes) include increased enforcement of forest protection legislation by government agencies, improved pasture and stock management by ranchers, a reduction in per capita demand for beef among domestic and international consumers, and an accelerated decline in human population growth in high-consumption countries.

As a heuristic, we conducted this threat-mapping exercise for 12 examples chosen to represent different threatening processes and the diversity of ecological and socioeconomic contexts in which they arise (see ref. [31]). We identified nine main clusters of actors (rows in Fig. 2), classified by how their behaviour impacts conservation targets. Producers and extractors of natural resources, conservation managers, and consumers are commonly identified as targets for behaviour change interventions in conservation and other sectors. However, we also identified other actor groupings, including manufacturers and sellers, financiers, policymakers, voters, communicators, and lobbyists, all of whom may have considerable, usually indirect, influences on conservation outcomes, yet are commonly overlooked when it comes to behaviour change interventions. Because our clusters of actors are operationally defined, they align well with the diversity of behaviour changes we identified (Fig. 2, right-hand column) – reducing consumers' purchases of high-footprint items, directing financiers' investments towards less damaging production technologies, and so on. Our clusters can also be mapped onto more conventional, organisational groups (such as citizens or businesses, intermediate columns in Fig. 2), but because such organisational groups impact conservation targets in heterogenous ways, their correspondence with behaviour changes is much weaker than for our typology.

Prioritising behaviour changes

After examining all major threats to a given conservation target and identifying promising behaviour changes involving specified actors, the next step is to prioritise behaviour changes and in turn the interventions potentially capable of achieving them. We suggest this should focus on two main characteristics that together determine the impact of behaviour change interventions[48,74]. The first is the target behaviour's potential, if changed, to improve the state of the conservation objective (by analogy with the climate change literature, its *technical potential*). In the Amazon (Fig. 1), both enforcing forest protection laws and providing herd management support that is conditional on ranchers stopping clearance, for example, might be considered to have greater technical potential than slowing population growth in beef-consuming countries (which may have only limited effect if per capita demand continues to rise). Prioritising behaviours for research and intervention on the basis of their technical potential – considered an omission in behavioural science contributions to climate change mitigation[48,75,76] – ensures that resources and efforts are allocated toward the behaviours with the greatest potential to effectively mitigate biodiversity threats.

The second aspect to consider in prioritisation is the behaviour's *plasticity*, referring to the degree to which a target behaviour can be changed by a specified intervention[48]. For example, to what extent can behaviour change interventions increase the share of plant-based food in overseas or Brazilian diets, or improve the cattle and pasture management of Amazonian farmers? Due to the current paucity of conservation-focused behaviour change interventions, good estimates of behavioural plasticity will often be lacking. Instead, evidence from interventions targeting comparable behaviours relating to other actors, contexts, or domains may serve as useful proxy indicators until more direct evidence becomes available[74]. Although considerations of technical potential and behavioural plasticity should guide which behaviours to study and intervene against, we note that additional considerations may become pertinent when selecting interventions for implementation (e.g., feasibility, stakeholder support, and costs)[77,78].

Given the range of actors involved in causing ecosystem change and the complexity of their behaviour, standalone behaviour change interventions are unlikely to effectively mitigate a biodiversity threat (as illustrated in Fig. 1). Thus, while individual-level interventions – for example, targeting specific farmers, manufacturers, or investors – may well form an important part of the solution, they will usually be insufficient on their own. For example, successfully incentivising ranchers in one Amazonian municipality to retain their remaining forests will be of little benefit to biodiversity if prevailing market failure or weak institutions continue to incentivise forest clearance elsewhere. Tackling more systemic drivers, such as environmentally damaging subsidy regimes, corporate interests, poor governance, and persistent norms, also necessitates population-level interventions that can alter economic systems, institutional systems, and physical infrastructure. Importantly, the intent here is not to undermine the legitimacy of individual-level interventions – quite the contrary. Systemic changes also cannot be achieved without individual-level behaviour changes and support[48,79,80]. Different levels of intervention must work in concert, which requires a holistic understanding of the determinants of human behaviour.

Building a robust evidence base

Generating evidence on behaviour change interventions for biodiversity conservation demands a mix of methods, including experimental and observational studies using quantitative and qualitative techniques[81–83]. Critically, to build an evidence base, these studies must be based on mapping or scoping of the existing literature or reviewing it with a view toward synthesising it[84]. They also need to be embedded in relevant conceptual or theoretical frameworks, coupled with a theory of change, and designed with the statistical power to answer the study questions. This might include, for example, taking a systems perspective[83], as well as using a taxonomy or typology of interventions[85,86].

Behavioural responses and the effectiveness of interventions are likely to vary between social and cultural contexts. Assessing the effect size of interventions in different settings will be key to building a robust evidence base that has global application. Improving the crosscultural profile of behavioural science evidence is thus imperative, and particularly so for biodiversity conservation where many problems are centred outside Europe and North America. Achieving this will, however, be challenging given that the research capacity in behavioural science remains low in high-income countries and even lower elsewhere. International partnerships will therefore be one important strand of building capacity across regions.

Emergent research questions

Given that behavioural science research into conservation-related problems is still in its infancy, many important questions remain unanswered. In this final section, we outline four higher-order questions we believe could impact the effectiveness of interventions aimed at reducing people's negative impacts on biodiversity, natural habitats, and the services provided by ecosystems. All necessitate close collaboration between behavioural scientists and conservation researchers and practitioners.

The first research question deals with prioritisation. As with climate change interventions, there is a clear need for a more systematic understanding of the technical potential of different behaviour changes: which ones, if delivered, would be most likely to reduce a threat and thereby enhance the status of the conservation target, taking into account other threats it faces? Given the focus of many recent environmental interventions on appealing, tractable but relatively low-impact behaviour changes (e.g., eating more locally grown food or avoiding plastic drinking straws), such prioritisation is badly needed. A further consideration here is how far such a behaviour change might reduce (or indeed increase) threats to other conservation targets.

Our other suggested research questions are aimed at improving our understanding of the plasticity of priority behaviours: which interventions work best to alter them, and how does this vary across contexts? One key aspect is exploring how the suitability of behaviour change interventions changes as a function of the level of deliberation and perceived importance of the decision being made. Consider contrasting interventions aimed at increasing how often consumers buy sustainably (rather than unsustainably) sourced fish. For someone making a weekly shopping trip such a choice may be performed with limited deliberation, which means that interventions targeting automatic decision-making processes may be effective[87]. However, for other actors, such as supply-chain managers making bulk purchases for supermarkets, different interventions – perhaps motivated by limiting reputational risk – will probably be required. At the level of decision-makers, designing national or international fisheries policy other sorts of interventions[88] – potentially linked to cessation or realignment of taxpayer subsidies – might need to be considered.

This example also illustrates our next research question: how the effectiveness of behaviour change interventions varies with the financial and psychological costs of the change for the target actor. In some instances, actors may benefit directly from pro-conservation behaviour (e.g., because eating more sustainably sourced fish aligns with other values). But sometimes those choices may carry costs (e.g., sustainable seafood may be more expensive or difficult to source). In the case of the supermarket chains, there may be financial and administrative costs to switching suppliers, at least over the short term. Policymakers will also face strong lobbying pressure to continue to support the status quo policies. Clearly, different interventions will be needed across such diverse circumstances.

Lastly, how can practitioners design interventions to ensure that behaviour changes persist over the long term? Although many intervention studies do not evaluate persistence over time, those that do commonly observe that effectiveness wanes[89–91]. In some contexts, it might be possible to design one-off interventions with long-lasting effects, but in others, delivering lasting change may necessitate recurring rounds of intervention, or the repeated introduction of novel interventions. Better understanding the persistence of intervention effects will be key to sustaining beneficial behaviour change.

Many more questions will emerge as this field develops. Addressing them will require fresh partnerships and continued commitment to work across disciplines and in unfamiliar circumstances. Nevertheless, we submit that there are few other opportunities where behavioural scientists have such potential to tackle one of the great challenges of our age. We hope this Perspective can help inspire this critical work.

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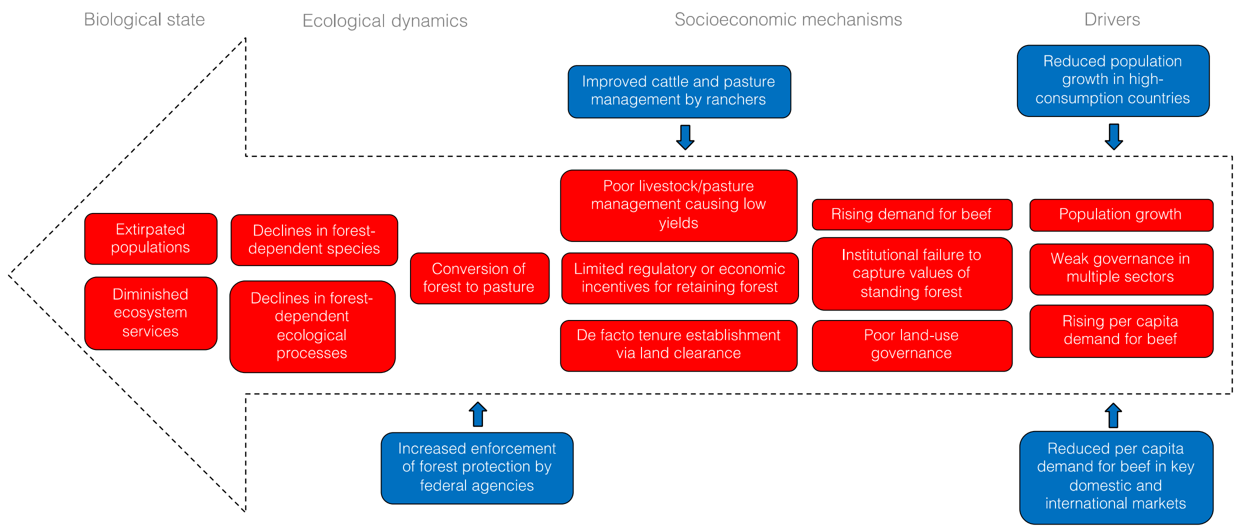

Fig. 1. Conversion of Amazon forest to cattle pasture in Brazil. This example characterises (in red boxes) the threat to the Amazon forest from conversion to cattle pasture. Potentially beneficial changes in the behaviours are in blue boxes. This threat chain addresses only one of several interacting threats impacting the conservation target. The threat chain model is adapted from Balmford et al.[19]

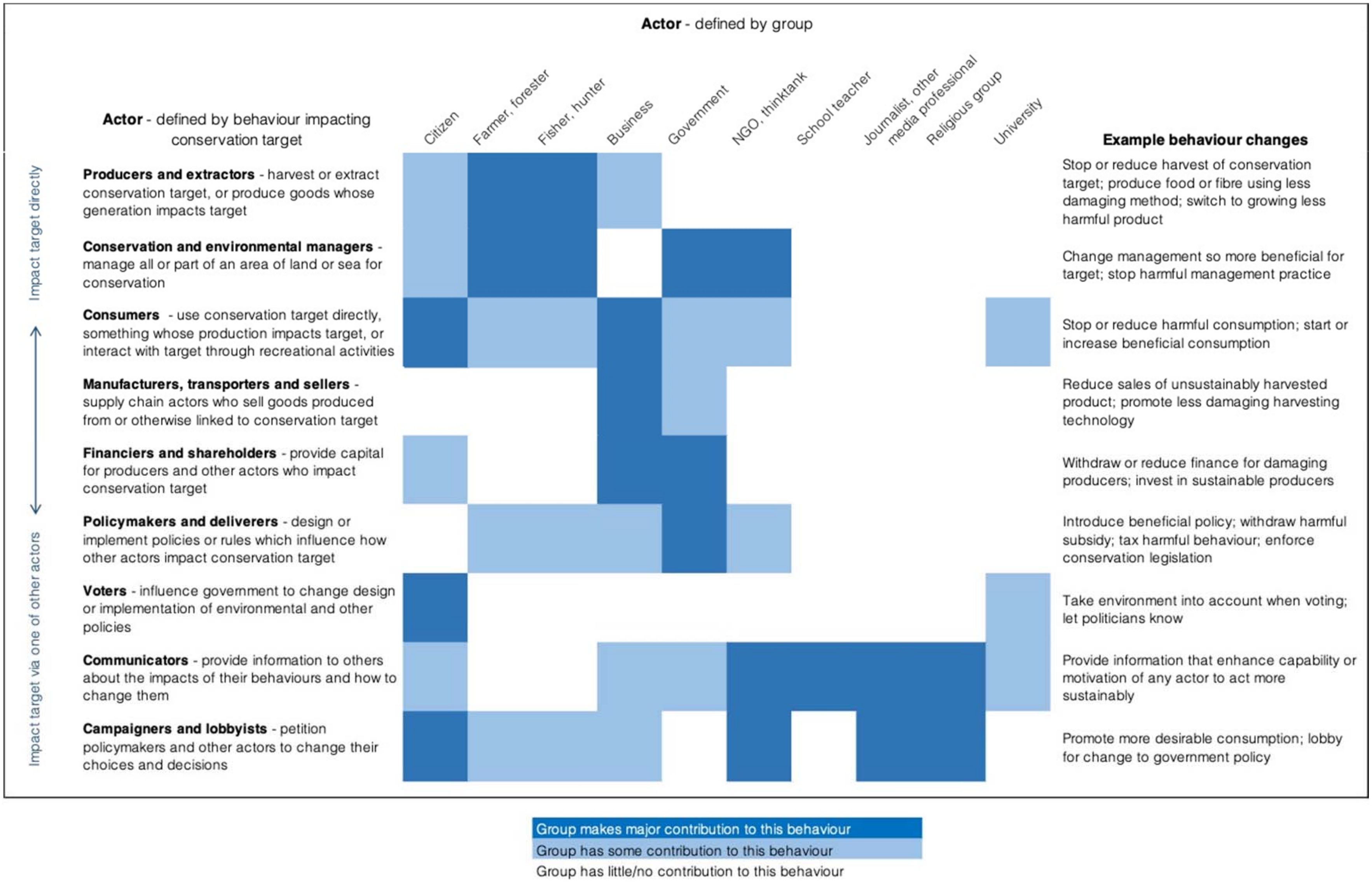

Fig. 2. Classification of actors according to their behavioural impacts on conservation targets (rows) and by their organisational affiliation.